

INSPECTING GEOTOURIST MAPS TO ENHANCE VISUAL GEOSCIENTIFIC COMMUNICATION

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Abstract

Geoheritage is becoming popular due to the wide range of educational and promotional opportunities. One way to promote geoscientific heritage is geotourism, which helps society to explore the values of the abiotic environment. Geotourism is linked to geoparks, where sustainable tourism, geoconservation, and geoheritage management are the most important tasks. The genre of geotourism maps is a suitable form of presentation and geoscientific dissemination. However, they do not always meet basic visual and cartographic requirements of effective communication. The European Geoparks Network (EGN) is made up of several European geoparks. In this study, we have collected geotourism maps from each member. The images were evaluated using a comprehensive method examining interpretability, map accessorial, topographic content, and visual attributes. Conclusions can be drawn on the quality of visual communication of each geopark by evaluating the results. We provide basic suggestions to improve visual communication, making scientific information more understandable to geotourists.

Keywords: geodiversity, GIS, Austria, Hungary, geosciences

GEODIVERSITY AND GEOHERITAGE

Geodiversity is a term relating to the variety of inanimate geoscientific values (geological, geomorphological, pedological, hydrographical, mineralogical, and palaeontological) of the Earth. The concept of geodiversity was proposed in the 1990s. However, the use of the term is not yet widespread. The various methods of geodiversity assessment draw attention to these values and reveal areas that can be further investigated to identify geosites and determine geotourism potential. Being the ‘backbone of geoheritage’ (Gray, 2018), the investigation of geodiversity and its assessment is essential before any kind of tourism, conservational or infrastructural utilisation (Zwoliński, 2018).

Geoheritage is a part of the Earth's identified geodiversity (Brilha, 2016; Zwoliński, 2018). This discipline includes the recognition, inventorying, management, and conservation of valuable and spectacular geoscientific objects, such as cliffs, caves, key sections, and outcrops (called geosites). It focuses primarily on the diversity of minerals, rocks, and fossils, but also incorporates historical, cultural, aesthetic, and religious values. The inventory of geoheritage includes globally, nationally, and locally important geoscience objects too – but their geotourism importance and potential are determined by the consideration of cultural and ethnographical additional values (Brocx & Semeniuk, 2007).

WHAT IS A GEOPARK?

A geopark is an institutional body responsible for the protection, management, and tourism utilisation of geoheritage values. It is established on the important geosites in a certain area having high scientific quality, assessed according to their rarity, aesthetic or educational attractiveness. Geosites in geoparks may also have archaeological, ecological,

ethnographical, historical, and cultural values too. Geoparks also have an important role in disseminating scientific information: their geoeducational activities help to understand the importance of geodiversity, geoheritage, and their conservation (Zouros, 2008). The international organization for UNESCO-recognised geoparks is the Global Geoparks Network (GGN) with 168 members worldwide (Global Geoparks Network, 2022).

The EGN (European Geoparks Network) is an organization including all 88 (2021) global geoparks in Europe (Fig. 1). Its main goal is to establish collaboration to protect and promote geoscientific and geotourism values of protected areas and to organise geoeducational activities (Zouros, 2008).

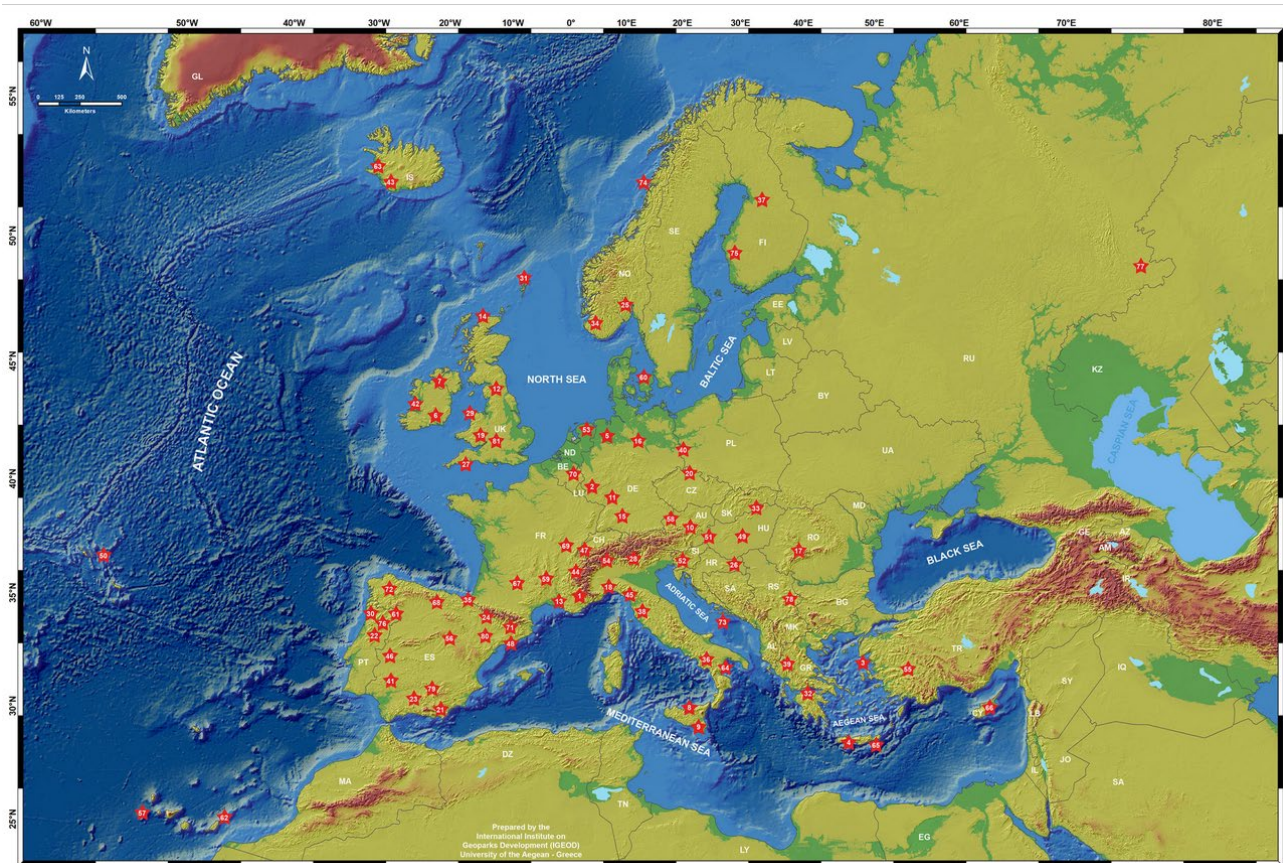


Figure 1. The distribution of EGN members (as of 2020, source: europeangeoparks.org)

GENERAL MAP USE AND READING

One of the most common methods of communicating and displaying spatial information is mapping. These products are also an important tool for displaying scientific results, which can be used to further analyze data or present them directly. Within earth science, the meanings of maps can greatly vary. Maps related to different science fields have different meanings for users. The users do not see background databases or the analytical processes when reading maps, only the graphical visualisation of the results. For this reason, it is important to make sure that the data displayed on the map is easy to understand for the reader as well. The finished product has to represent corresponding area realistically and in a well-interpretable way (DiBiase, 1990; DiBiase et al., 1994).

Maps are not always made by cartographer specialists, which can be a problem in complying with basic cartographic considerations. Thematic data is not always properly communicated to users, so the map is difficult to read and interpret. Proper interpretation of maps requires basic map objects such as scale, legend, and orientation. In addition, to taking cartographic aspects into account, the basic graphic factors should also be observed, as the map is a graphic end product, either in printed or interactive form. Therefore, a properly constructed map brings the user (both in cartographic and graphic terms) closer to understanding the depicted phenomenon, so the processes can be easy to understand (DiBiase et al., 1992).

GEOTOURIST MAPS

The use of geotourist maps is not yet widespread in Hungary. Geological maps in most countries are issued by geologists, edited, or derived based on field observations. An expert surveys geological formations with the help of a topographic map suitable for orientation and navigation. These maps include specific information, that is difficult for tourists to interpret. Due to the dense thematic content, these maps are not easy to use for field orientation, as they contain little additional information to help with field orientation and locating tourist destinations. Such maps were made primarily for desktop use. The number of symbols on the map is closely related to the size of the area and the map scale.

Most of the used map symbols are coloured polygons referring to different lithological categories. As there are other line and point symbols to present (e.g. tectonic lines and boreholes), the map can become easily 'overloaded'. This amount of scientific information is unnecessary for tourism purposes and cannot be disseminated easily. The spreading need for natural activities and geoscientific information also brought the development of tourist routes and educational trails, which should be depicted on maps, as they are essential for field navigation and finding geosites.

However, geotourist maps usually contain a limited amount of geological/geoscientific information that helps the understanding of the evolution and processes of the corresponding area. In addition, geosites and other infrastructure elements can be presented in these publications and maps. However, this genre is not yet fully developed, as it is very difficult to find the balance between scientific and tourism content (Albert, 2004; Albert & Pál, 2018).

COLLECTING GEOTOURIST MAPS

The research is based on a database, in which the maps to be evaluated, the evaluation criteria (Table 1.), and the results were recorded. The first step during database building was to download the latest list of the members of the European Geoparks Network. We have also noted the country of each geopark, as this factor had a role later in differentiating the results. After these initial preparations, we have started to collect geotourist maps by looking through the official websites of the designated geoparks. We have downloaded the latest maps as raster image files (where these were available) in the case of each geopark with the best possible image quality.

However, we noticed that there are also interactive maps on the websites of some geoparks (42 pieces), so we uploaded the link of these to the database in addition to the raster files. These web pages show data about geoparks and related services with varying data density and quality. In most cases, these are based on a vector background that can be either uniquely edited (e.g. Arouca Geopark [Portugal]) or open-source (e.g. OSM – Bergstrasse-Odenwald Geo-Naturpark [Germany]). Geosites and the presentation of hostelry, restaurants, and other services usually appear in the background with various thematic geotourist functionalities (e.g. geosites, visitors' centers, and educational trails). Some information about the displayed features appear after a click, or the visitor is directed to a subpage, where additional materials can be found.

In the case of some geoparks, no available raster-based or interactive maps were found on the Internet (16 geoparks). In such cases, we tried to contact the corresponding geopark's staff for relevant geotourist maps. We were provided with 6 maps this way. In the case of the Novohrad-Nógrád Geopark (Hungary), we used our physically available map that was scanned in high resolution and recorded in the database. A total of 78 maps of the 88 geoparks (one per each) were collected (Figure 1.). The images are mainly in raster formats (JPEG, PNG), but there are also some PDF ones in the inventory.

EVALUATION METHOD

After collecting the maps, we started processing them, which was done using the evaluation method presented by Pál & Albert (2021). The initial approach of this system examined the objective characteristics of geoscientific maps. Its core was worked out during the XX. Carpathian-Balkan Geological Congress in 2014 (Tirana, Albania), where the greatly varying quality of the presented studies' map figures triggered the idea of a systematic analysis. Gáspár Albert collected some samples here and started to collect the criteria that can be evaluated. The main idea of determining the factors that makes a geoscientific map better or less interpretable was slightly modified by this paper to be compatible with geotourist maps. The first criterion of the evaluation is the visualization quality that characterizes each map as a synthesis of visual variables. Three groups are defined based on:

- the use of colours and symbols and their placement,
- the style and readability of text elements and toponyms (if they are present),
- the balance between the thematic content and the base map,
- and the overall visual quality of these components together.

An important evaluation criterion is the map type that is determined based on the functionality of each map. Three distinct types are defined: overview, main and detail maps. The map accessorial, topographic and thematic content as well as base map copyright issues were also analysed (Table 1).

Table 1. The evaluation system criteria

→ Visualisation
• Excellent: The elements displayed on the map are balanced, and suitable for the purpose, making it easy for the user to read and interpret. The resolution in terms of image quality is good. • Medium: The resolution still meets the expectations, but the map is no longer easy to read and interpret due to inaccuracies or distortions. The elements used and the purpose of the map is not always harmonized, the thematic content and background do not precisely fit together. • Poor: The map content is difficult to read and interpret, and thematic content and symbols are not necessarily related to the target theme of the map.
→ Map type
• An overview map is for showing the location and the geographical context of a study area. These maps are often of a small-scale, solitary, or paired with the main map. • The theme and the area are usually presented on the main map on a large scale. It has a more elaborate symbol use and detailed content than the overview map showing the results of the research works. • The third category is the detail map, which is always closely connected to the main map. It presents a smaller area of the main map on a larger scale. The main map is always present together with a detail map.
→ Map content
• Coordinates: lines of the geographical degree network, degrees • Orientation: north direction marking • Scale • Legend: used symbols and signs are summarized separately and explained • Toponyms • English language: the text information displayed is in English in addition to the language of the country of the geopark • Descriptive texts/photos: any text descriptive with photos, such as geolocation
→ Topographic content
• Relief: presentation of topography in different forms (contour lines, hypsometry, shading) • Hydrography: water network represented byline and/or surface signs (watercourses, lakes, rivers, channels, springs, wells, marshes) • Road network: represented by a byline and/or surface signs (roads of international and local significance) • Administrative boundaries: state borders, borders of smaller administrative units • Settlements: representation of a settlement with a surface method or points • Toponyms: names of natural and manmade objects
→ Thematic content
• Geology: the geological composition of the area by any method • Geotopes/geolocation: mark geolocation with dots/point • Tourist trails: marking the tourist road network with signs • Geopark boundary
→ Base map types – copyright issues
• Copy ua means an unreferenced, scanned raster file that was used to create the base. • In the case of Copy a, the scanned raster is accurately referenced. • In the case of Edited, the topographic/thematic data used is referenced after some base map editing. • While Vector base maps also look to be edited, no reference can be found. If the base map exists, but we have no information about it. • Then the No data mark is applied. • The last category is the No base map when there is just thematic content without any basic background.

RESULTS

The results are calculated based on pre-defined country groups instead of geoparks (Fig. 2). In this way, the various parts of Europe can be evaluated separately and specific recommendations and map quality conclusions can be drawn. The country groups are the following:

- **Southern Europe:** Italy, Portugal, Spain
- **Southeast Europe:** Cyprus, Greece, Croatia, Romania, Serbia, Turkey
- **Northern Europe:** Turkey, Denmark, Finland, Iceland, Norway, Russia
- **Central Europe:** Austria, Czechia, Poland, Hungary, Slovakia, Slovenia
- **Western Europe:** Belgium, the United Kingdom, France, the Netherlands, Ireland, Germany

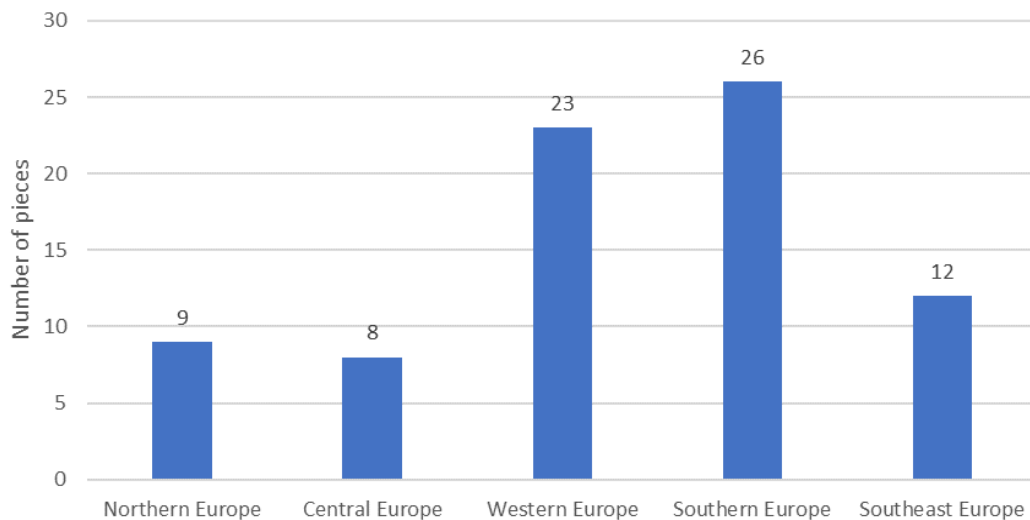


Figure 2. Number of maps collected from each country group

Thematic data representation

Visualization

According to the three visual categories (excellent, medium, and poor), Central Europe has reached the best results, as it has the highest proportion of excellent maps in the country groups, followed by Southern Europe and Southeast Europe (Fig. 3). In the latter group of countries, medium quality has the highest proportion. Surprisingly, Western Europe has the poorest map visualisations. The diagrams also show the proportion of the geoparks where no maps were available.

Map types

According to the results, main maps are the most common in all five country groups. In the case of Western and Southeast Europe, there is only one overview map next to the main maps, while in the other 3 cases (Northern Europe, Central Europe, and Southern Europe) an overview map and a detail map are also shown (Fig. 4). Most overview maps are present in the case of Southern European geoparks.

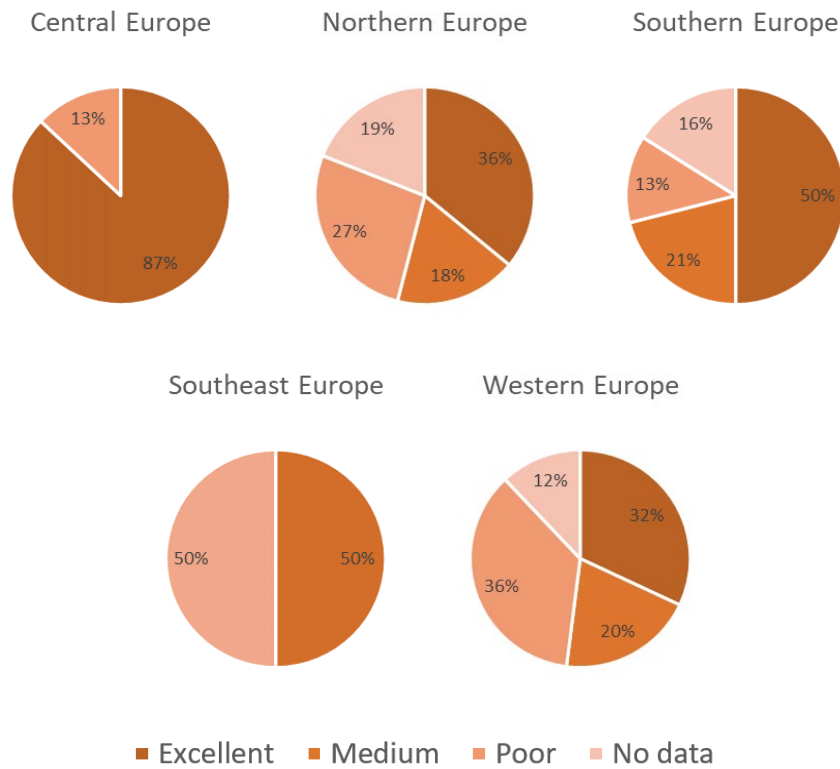


Figure 3. Visualization proportion by country group

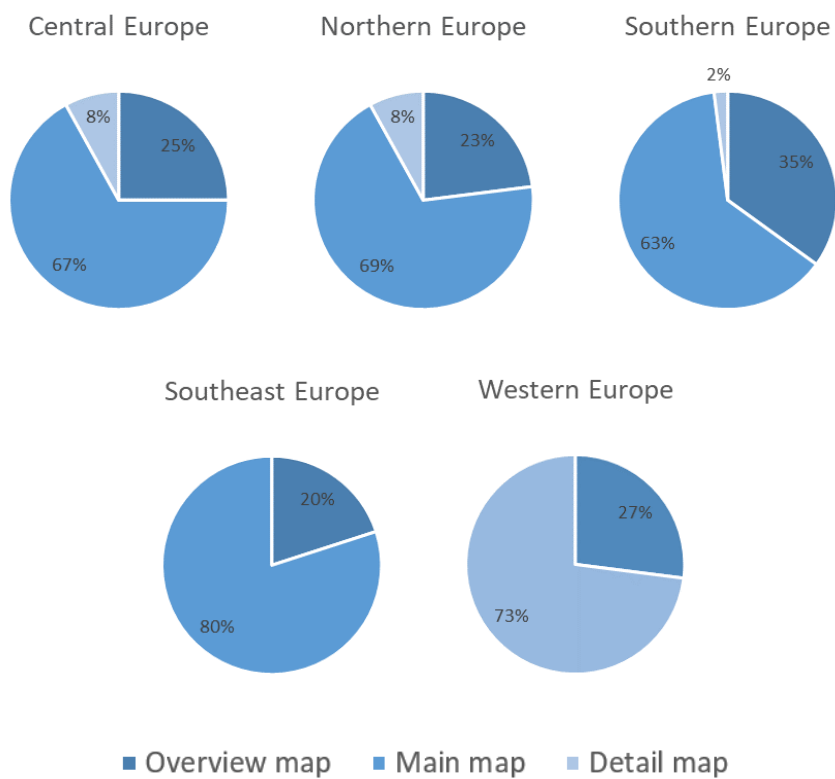


Figure 4. Map types by country groups

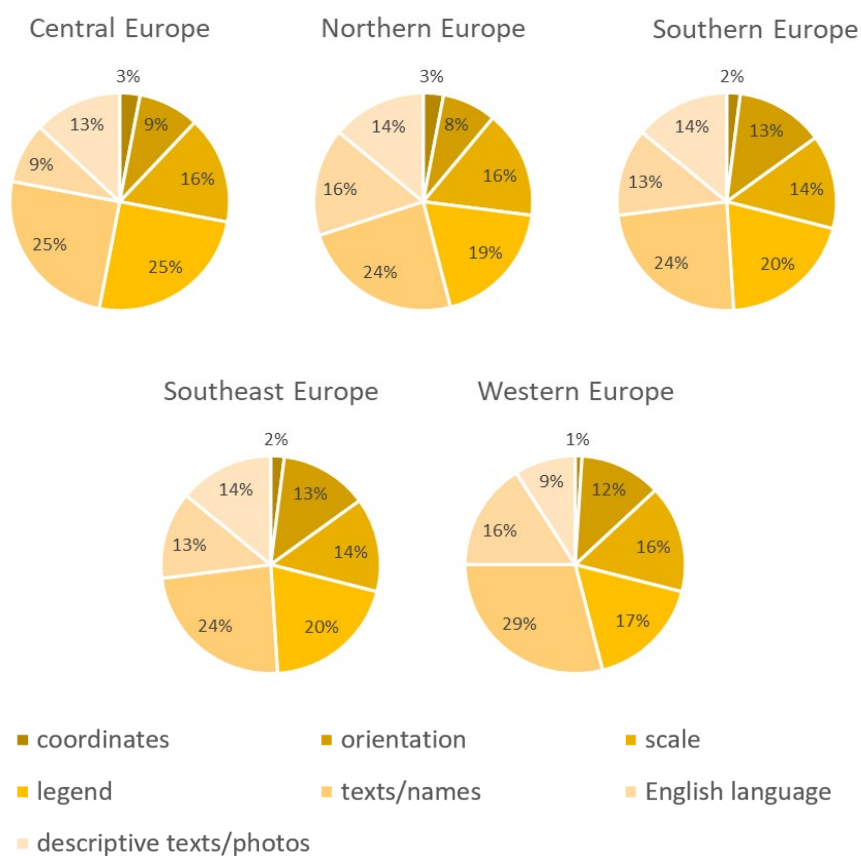


Figure 5. Map content by country group

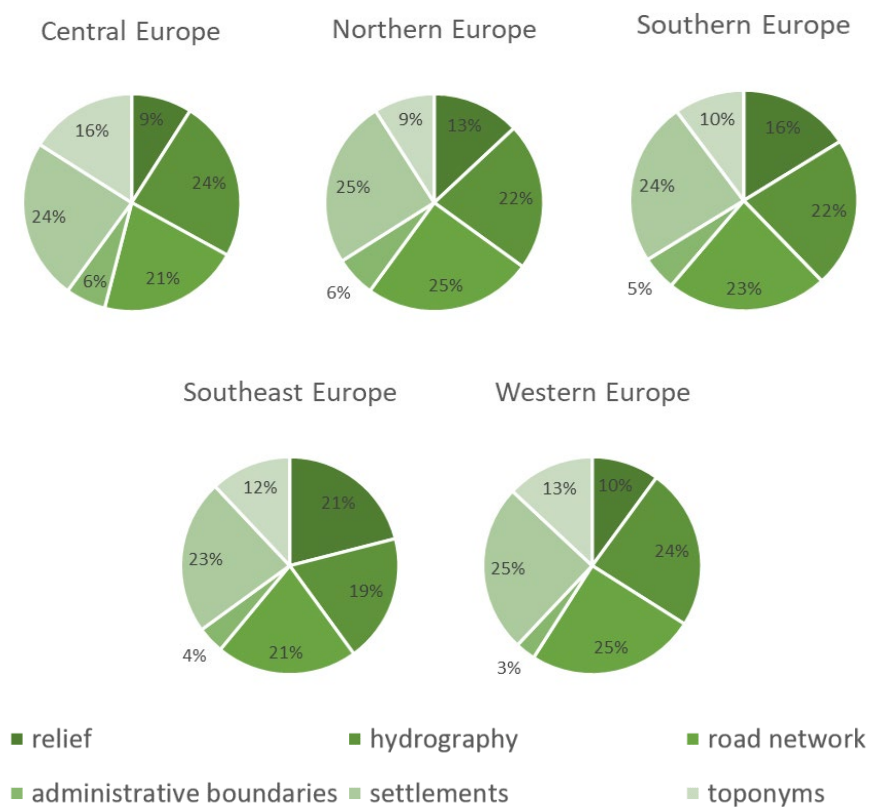


Figure 6. Topography content by country group

Map content

In most cases legend and toponyms appear on the maps, in Southeast Europe, the scale and nomenclature are the vast majority. Orientation is almost the same in all 5 cases, and coordinates can be found in only one case, this map element appears the least often (Fig. 5). The English language is present in relatively few cases, which is surprising since the geoparks, that publish the map, are members of an international organization.

Topographic content

In all cases, the presentation of road network and hydrographic elements are the most common, followed by the representation of settlements with a smaller number (Fig. 6). Geographical names, topography, and administrative boundaries are shown in the smallest proportion. Maps of the Central European group show the smallest proportion of relief. Maps of Northern Europe contain the least toponyms. Administrative boundaries are rarely present in all 5 cases, only 2-6 maps.

Thematic content

The boundaries of the examined geoparks are marked on the map except for a few cases. In addition, to the representation of the boundaries of geoparks, the representation of geosites is present in an almost equally high proportion. The representation of geology and hiking trails network is far behind the other two thematic elements. In most cases, the proportion of these two topics is almost the same for groups of countries. The smallest proportion of tourist routes occur in Central Europe, while the lowest number of geological layers appears on the maps of Southeast and Northern Europe (Fig. 7).

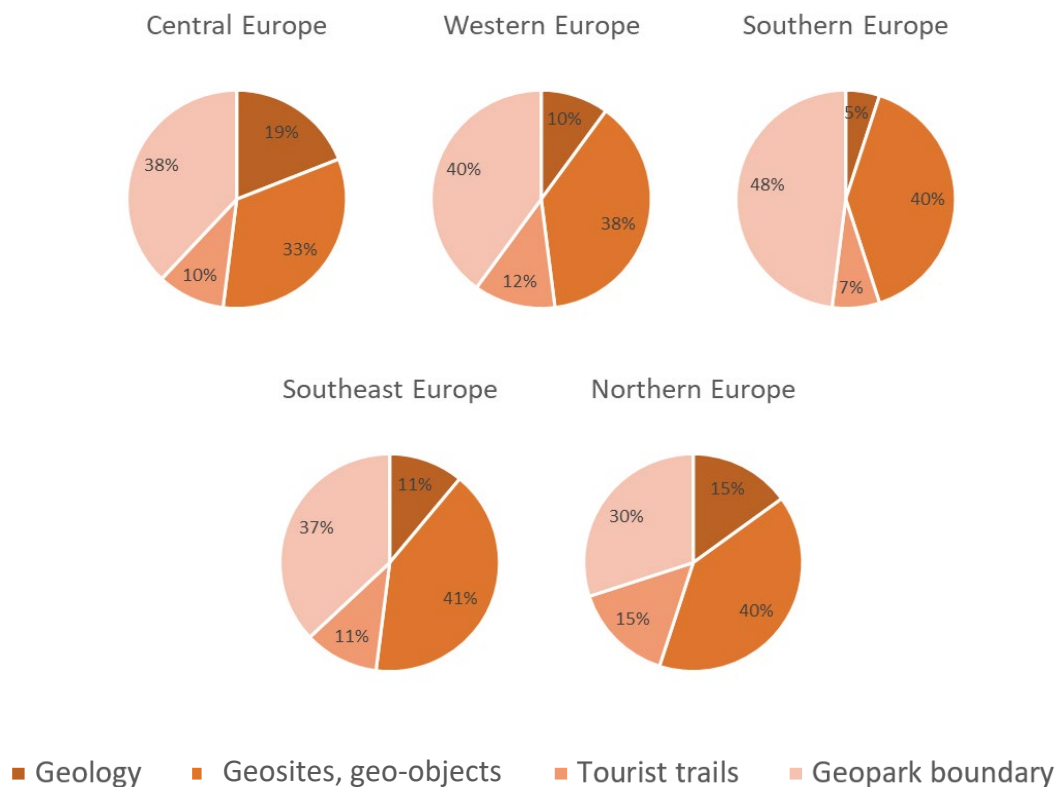


Figure 6. Thematic content by country group

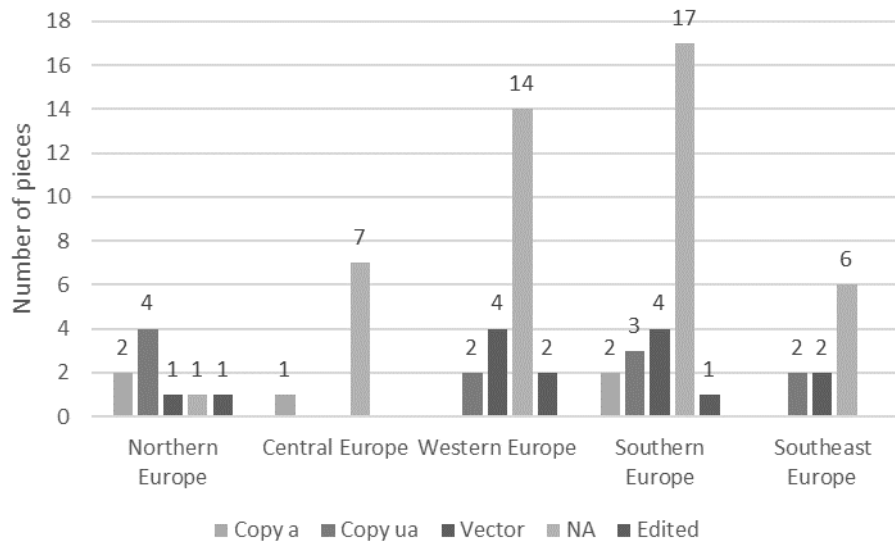


Figure 7. Base maps type by country group

Base maps type

When examining base maps, Northern Europe does not fit into the data of the other groups of countries, as here most maps are in the **Copy ua** category (Fig. 7). For the other 4 groups of countries, there are mostly no base map. On the maps of Southeast Europe, we only find **Copy ua** and **Vector** types. In central Europe, where there is a base map, **Copy** is the category.

CONCLUSION

During the research, geotourism maps of EGN members were collected and examined. For this, we used a system of criteria taking visual and cartographic attributions into consideration. After the evaluation, we got a more comprehensive picture of each group of countries based on the different categories. Examining the visualization, we can state that Central Europe got the best results and Western Europe the worst (Fig. 2). For the map type, all three types are displayed for Central, Northern, and Southern Europe (overview, main, and detail map as well). In these three cases, the detail map is uniform in the smallest proportion. Examining the map content, it can be stated that the coordinates are the objects that appear in the smallest proportion in all 5 cases. For the groups of countries, the examined objects appear on the maps in a nearly similar proportion. Even for topographic content, there are only minor outliers between groups. The boundary representation of the geopark is the most prominent in the geotourism maps of Southern Europe. When examining the other components, we get almost similar proportions for each group of countries. The examination of the base map type revealed varied results. For geotourism maps of Western Europe and Southern Europe, no data is the most common.

Thus, it can be stated that the geotourism maps of the EGN members differ only in some cartographic elements. Visually, Central Europe is the most prominent, and almost similar results were obtained for all other cartographic objects.

It is a basic cartographic aspect to have orientation and scale on the map, as the lack of these can make it very difficult to read the map. The orientation is the lowest on the maps of Central Europe and Northern Europe, in almost the same number as in the other groups of countries. The scale is almost the same for all groups of countries. On geotourism maps, it may be a basic requirement to mark geotopes in some way. The maps of Central Europa also stand out on this basis. It appears on the maps of Southern Europe in the smallest proportion.

All in all, most, but not all, geotourism maps belonging to the Central Europe group of countries are the most outstanding in terms of evaluation criteria.

In order to show the land values accurately and to convey them in a clear and easy-to-understand way, it is recommended to prepare the geotourism maps by the basic aspects. For a more consistent display, EGN members may be encouraged to follow a jointly developed scheme when designing and editing maps. The common signal code would make it much easier for map users to get to know the area through the maps.

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